CLAIMS

I Claim:

1. An apparatus **(10)** for splicing a heatable section **(20)** of a tubular heater **(11)** to a cold section **(22)** thereof, said heatable section **(20)** having opposing ends **(80,82)** including an outer sheath **(78)** and a heating element **(84)**, said heating element **(84)** being inside said outer sheath **(78)**, said cold section **(22)** having opposing ends **(90,92)** including an outer sheath **(88)** and a cold pin **(94)**, said apparatus **(10)** comprising:

an enclosure **(12)** defining a chamber **(62)**, said enclosure **(12)** further defining openings in communication with said chamber **(62)**;

at least one welding tip **(30)** extending into said chamber **(62)** and capable of melting said cold pin **(94)** and welding the ends **(80,90)** of said heatable and cold sections **(20,22)** together;

wherein one end **(80)** of said heatable section **(20)** and one end **(90)** of said cold section **(22)** are each directed into one of respective said opposing openings to a predetermined depth, said welding tip **(30)** being placed in close proximity with said cold pin **(94)** of said end **(90)** of said cold section **(22)** forming a molten pool **(128)** thereon, said ends **(80,90)** of said heatable and cold sections **(20,22)** being brought into contact wherein said molten pool **(128)** and said heating element **(84)** form a connection therebetween as said molten pool **(128)** solidifies.

2. The apparatus **(10)** of claim 2 wherein said heatable and cold sections **(20,22)** are circular in cross section.

3. The apparatus **(10)** of claim 1 wherein said welding tip **(30)** is a Tungston Inert Shielded Gas welder.

4. The apparatus **(10)** of claim 1 wherein said chamber **(62)** is filled with an inert gas.

5. The apparatus **(10)** of claim 1 wherein said heating element **(84)** and said cold pin **(94)** are substantially centered within respective outer sheaths **(78,88)** by a filler material **(86)**.

6. The apparatus **(10)** of claim 5 wherein said filler material **(86)** is magnesium oxide.

7. The apparatus **(10)** of claim 1 further comprising a pair of rollers **(16,18)** in communication with said chamber **(62)** and aligned with said opposed openings.

8. The apparatus **(10)** of claim 7 wherein a platform **(35)** extends from said enclosure **(12)** in alignment with said pair of rollers **(16,18)**.

9. The apparatus **(10)** of claim 8 wherein said platform **(35)** includes a notched portion **(37)** formed therein for alignment with said opposed openings.

10. The apparatus **(10)** of claim 7 further comprising an actuator **(24)** resting on said pair of rollers **(16,18)** for directing said cold section **(22)** therealong.

11. The apparatus **(10)** of claim 1 wherein said welding tip **(30)** being capable of forming a weld joint along a juncture **(136)** of said ends **(80, 90)** of said heatable and cold sections **(20,22)** thereby establishing a splice therebetween.

12. The apparatus **(10)** of claim 1 wherein said at least one welding tip **(30)** comprises a Tungsten Inert Shielded Gas welder.

13. The apparatus **(10)** of claim 1 wherein said at least one welding tip **(30)** comprises an orbital Tungsten Inert Shielded Gas welder.

14. A method of splicing a tubular heater **(11)** comprising a heatable section **(20)** and a cold section **(22)** , said heatable and said cold sections **(20,22)** each having an outer sheath

(78,88) with respective first and second ends (80, 82, 90, 92), said heatable section (20) having a heating element (84) for generating heat and said cold section (22) having a cold pin (94) for conducting an electrical current using a splicing apparatus (10) comprising an enclosure (12) defining a chamber, (62) said enclosure (12) further defining openings in communication with said chamber (62), at least one welding tip (30) extending into said chamber(62), said at least one welding tip (30) being capable of melting said cold pin (94) and then welding said first ends (80,90) of said heatable and cold sections (20,22) together, comprising the steps of:

a) directing said first ends (80,90) of said heatable and cold sections (20,22) toward each other through respective said openings to a predetermined depth;

b) placing said welding tip (30) in close proximity with said cold pin(94);

c) melting a portion of said cold pin (94) along said first end (90) of said cold section (22) with said welding tip(30);

d) pressing said first ends (80,90) of said heatable section (20) and said cold section (22) together forming a juncture (136) therebetween; and

e) welding along said juncture **(136)** of said outer sheaths **(78,88)** with said welding tip **(30)** to form a weld joint **(134)** therebetween.

15. The method of claim 14 wherein said step c) is performed using a Tungsten Inert Shielded Gas welder.

16. The method of claim 14 wherein said step e) is performed using a Tungsten Inert Shielded Gas welder.

17. The method of claim 14 wherein said steps c) and e) are performed in the presence of an inert gas.

18. The method of claim 14 wherein said heating element **(84)** is centrally coiled along the length of said heatable section **(20)**.

19. The method of claim 14 wherein said step e) is performed using an orbital Tungsten Inert Shielded Gas welder.

20. The method of claim 18 wherein a portion of said heating element **(84)** is caused to extend outwardly from said first end **(80)**.

21. The method of claim 14 wherein said step d) juncture **(136)** is formed so that said heating element **(84)** and said melted

portion **(128)** of said cold pin **(94)** contact each other thereby forming a connection between said heating element **(84)** and said cold pin **(94)** as said cold pin **(94)** solidifies.

22. An apparatus **(10)** for splicing a heatable section **(20)** of a tubular heater **(11)** to a cold section **(22)** thereof, said heatable section **(20)** having opposing ends **(80,82)** including an outer sheath **(78)** and a heating element**(84)**, said cold section **(22)** having opposing ends **(90,92)** including an outer sheath **(88)** and a cold pin, **(94)** said apparatus **(10)** comprising:

an enclosure **(12)** defining a chamber **(62)**, said enclosure **(12)** further defining opposed openings in communication with said chamber **(62)** for receiving said heatable section **(20)** in one of said opposed openings and said cold section **(22)** in the other said opening;

a roller assembly **(14)** having first and second rollers **(16,18)**, said roller assembly **(14)** further including a staging portion **(15)** in communication with said enclosure **(12)** and a placement portion **(17)** extending from said staging portion **(15)**, said first and second rollers **(16,18)** being aligned with said opposed openings;

a platform **(35)** extending from said enclosure **(12)**, said platform **(35)** having a notched portion **(37)** formed therein

which is aligned with said first and second rollers **(16,18)** for carrying said heatable section **(20)** therealong;

an actuator **(24)** resting between said first and second rollers **(16,18)** along said placement portion **(17)** for directing said cold section **(22)** therealong,

at least one welding tip **(30)** extending into said chamber **(62)** and capable of melting said cold pin **(94)** and connecting the ends of said heatable and cold sections **(20,22)** together;

wherein upon respective ends of said heatable and cold sections **(20,22)** being placed in each of said opposed openings, said actuator **(24)** directing said cold section **(22)** so that said welding tip **(30)** may be placed in close proximity with said cold pin **(94)** for forming a molten pool **(128)** thereon, said ends **(80, 90)** of said heatable and cold sections **(20,22)** then being brought into contact with one another such that said molten pool **(128)** and said heating element **(84)** form a connection therebetween as said molten pool **(128)** solidifies.

23. The apparatus **(10)** according to claim 22, wherein said first and second rollers **(16,18)** are forced in rotational movement so that said heatable and cold sections **(20,22)** rotate in unison in an opposing rotational movement along said staging portion **(15)**.

24. The apparatus **(10)** according to claim 22, wherein said welding tip **(30)** may form a weld joint **(134)** along the juncture **(136)** of said ends **(80,82,90,92)** of said heatable and cold sections, **(20,22)** thereby establishing a splice therebetween.

25. The apparatus **(10)** of claim 22 wherein roller assembly **(14)** extends through said enclosure **(12)**.

26. The apparatus **(10)** claim 22 wherein said actuator **(24)** drives said cold section **(22)** into one of said opposed openings to a predetermined depth so that cold section **(22)** is rotatably carried by said staging portion **(15)**.

27. The apparatus **(10)** of claim 26 wherein said actuator **(24)** directs the ends **(80,82,90,92)** of said heatable and cold sections **(20,22)** into contact with each other after said welding tip **(30)** contacts said cold pin **(94)** for forming said molten pool **(128)** thereon.

28. An apparatus **(10)** for splicing a heatable section **(20)** of a tubular heater **(12)** to a cold section **(22)** thereof, said heatable section **(20)** including an outer sheath **(78)** having a heating element **(84)** therein substantially extending the length of said outer sheath, **(78)** said cold section **(22)** including an outer

sheath **(88)** having a cold pin **(94)** therein substantially extending the length of said sheath **(88)**, said apparatus **(10)** comprising:

an enclosure **(12)** defining a chamber **(62)**, said enclosure **(12)** further defining opposed openings in communication with said chamber **(62)** for receiving one said heatable section **(20)** in one said opposed opening and one said cold section **(22)** in the other said opening;

a platform **(35)** having a notch **(37)** formed therein extending from said enclosure **(12)**;

first and second rollers **(16,18)** having a staging portion **(15)** in communication with said enclosure **(12)** and a placement portion **(17)** extending therefrom in an opposing direction from said platform **(35)**, said first and second rollers **(16,18)** and said notch **(37)** being aligned with said opposed openings;

an actuator **(24)** positioned along said placement portion **(17)**;

a rotatable welding tip **(30)** and a fixed welding tip **(124)** extending into said chamber **(62)**, said rotatable welding tip **(30)** capable of melting said cold pin, **(94)** said fixed welding tip **(124)** capable of welding the ends of said heatable and cold sections **(20, 22)** together.

29. The apparatus **(10)** of claim 28 wherein once said heatable section **(20)** reaches said predetermined depth, said actuator **(24)** includes a roller **(120)** which extends downwardly into rotatable tangential contact with said heatable section **(20)** thereby constraining said heatable section **(20)** to rotational movement along said staging portion **(15)**.

30. The apparatus **(10)** of claim 28 wherein upon respective ends **(80,90)** of said heatable and cold sections **(20,22)** being placed in each of said opposed openings, said actuator **(24)** capable of directing said cold section **(22)** into contact with said rotatable welding tip **(130)** for forming a molten pool **(128)** thereon and with said fixed welding tip **(124)** such that after said molten pool **(128)** is formed, said actuator **(24)** directs said heatable and cold sections **(20,22)** into contact for said fixed welding tip **(124)** to weld the ends **(80,90)** of said heatable and cold sections **(20,22)** together.

31. The apparatus **(10)** of claim 28 wherein said first and second rollers **(16,18)** are placed in driven rotational movement so that heatable and cold sections **(20,22)** rotate in unison in an opposing rotational movement along said staging portion **(15)** so that fixed welding tip **(124)** forms a weld joint **(134)** along the

juncture **(136)** of said ends **(80,90)** of said heatable and cold sections **(20,22)**.